**The information revolution will transform education**

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Schools usually reflect the societies in which they are in. Take the example of America 200 years ago, people only needed a little learning from books because most people still lived a simple life based on farming. School started quite late in the day and ended early to leave time for the jobs students did for their families. In summer, school stopped so children could help their parents in the fields. There were only a few subjects, controlled largely by the teacher, and the aim was on developing basic skills.

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| B |

In that world, the one-room schoolhouse was enough. Teachers taught reading, writing, and simple mathematics to help with the skills students learned outside school. Since only few students went as far as high school, the need for higher levels of education, like college and university, was very small.

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By the late 1800s, more and more people were moving to cities and going to work in factories.To teach students the basic skills and simple facts they needed for jobs in factories, the first great revolution in schooling took place: the factory school model appeared. Schools were very big with many classrooms where students sat in neat rows with the teacher in front. Schools aimed at producing students with exactly the same types of skills. Students learned enough to work at jobs, in factories, that they would probably keep for most of their lives.Today many students still attend factory-model schools.

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Much of the day is spent only listening to lectures. Many classes teach skills for jobs that either no longer exist or will not exist when students grow up. It is clear that this type of schooling is not enough for the modern world. Only about 20 percent of working people now work in factories or on farms. People graduating from high school or college will average six to eight jobs over their careers, many of them requiring skills they don’t know about yet. About half of all employed Americans work with information—studying information that already exists, generating new information, storing and retrieving information. Soon a major part of this group will not even work in an office, but at home. Most people agree that this new way of life needs a new type of education

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In this new kind of school, all students will need to reach much higher standards of learning because everyone will have to be able to think to get a good job. People will also have to be able to learn many new skills from when they are young to when they are older. This new type of education will increase the links between students and their communities. The timing and location of education will also be more flexible, to suit and take advantage of changes in the workplace. Students will be expected to learn inside schools and outside of them too.

**Technology and the new model of learning and teaching**

Technology is changing the world, and with it education. It offers many new ways of learning, of teaching, and of running schools. It provides new ways for everyone in education to communicate openly with parents, communities, and students.   
  
  
Yet technology by itself is clearly not enough. Traditional schools have pushed individual performance and competition and have tried to stop students from working or even talking together. In the new model of school, the skills needed in today's workplace, such as, critical thinking, teamwork, compromise, and communication are important classroom experiences.   
  
  
This model of education means that students, teachers and schools will need to change the way they work. In the new model of school, students do many of the things that teachers did in the past. In small groups, individual students help each other. Because they are often the ones who know most about new technologies like the internet, students lead by example, helping their classmates work on problems. In this way, students begin learning from an early age how to communicate and how to take on greater responsibility for their own education.   
  
In the past teachers were the ‘bank of all knowledge’, but in the new model they act as guides who help students move through the information that technology makes available. They help students collect and organize information, decide on its value, and decide how to present it to others. Moving from group to group and from student to student, teachers help students stay focused and working at the limits of their abilities.   
  
  
**A New Model of Education**  
  
  
In this new model of school, education looks different than it does in most schools today. Schools might be open all day and all year, with groups of students coming in and out of classes. Classrooms might have students of different ages. Traditional 50-minute classes will become longer or disappear to suit activities made possible by technology. Longer projects will include different subjects, bringing together information that was covered before in different classes.   
  
  
Schools could be found in unlikely places—such as office buildings—or more traditional schools may have classrooms connected to businesses, hospitals, or homes. Secondary schools may make new links with colleges and community institutions to make the move from school to work easier. Individual classes will be connected to workplaces, providing job training that is far better and more useful than what is offered today. Technologies used at home will share lesson plans, homework, and tests both with students and their parents.   
  
  
The end goal of this new model of education is to encourage groups of lifelong learners, where thinking and cooperation is seen as very important. Within these communities, decisions will be made by those in the best position to make them—by students, teachers, and educational administrators.

**Digital Natives, Digital Immigrants**

By Marc Prensky   
  
Today’s students are not just very different from those of the past, nor simply changed their slang, clothes, body adornments, or styles, as has happened between generations previously. A really big *change* has taken place, – an event which changes things so fundamentally that there is absolutely no going back. This change is the arrival and rapid dissemination of digital technology in the last decades of the 20th century.   
  
Today’s students – K through college – represent the first generations to grow up with this new technology. They have spent their whole lives surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age. Today’s average college grads have spent less than 5,000 hours of their lives reading, but over 10,000 hours playing video games (not to mention 20,000 hours watching TV). Computer games, email, the Internet, cell phones and instant messaging are integral parts of their lives.   
  
It is now clear that as a result of this, today’s students *think and process information fundamentally differently* from their predecessors. These differences go far further and deeper than most educators suspect or realize. ‘Different kinds of experiences lead to different brain structures, ‘ says Dr. Bruce D. Perry of Baylor College of Medicine. As we shall see in the next installment, it is very likely that *our students’ brains have physically changed* – and are different from ours – as a result of how they grew up. But whether or not this is *literally* true, we can say with certainty that their *thinking patterns* have changed. I will get to *how* they have changed in a minute.   
  
What should we call these ‘new’ students of today? Some refer to them as the N-[for Net]-gen or D-[for digital]-gen. But the most useful designation I have found for them is ***Digital Natives.*** Our students today are all ‘native speakers’ of the digital language of computers, video games and the Internet.   
  
So what does that make the rest of us? Those of us who were not born into the digital world but have, at some later point in our lives, become fascinated by and adopted many or most aspects of the new technology are, and always will be compared to them, ***Digital Immigrants***.   
  
The importance of the distinction is this: As Digital Immigrants learn – like all immigrants, some better than others – to adapt to their environment, they always retain, to some degree, their foot in the past. This can be seen in such things as turning to the Internet for information second rather than first, or in reading the manual for a program rather than assuming that the program itself will teach us to use it. Today’s older folk were ‘socialized’ differently from their kids, and are now in the process of learning a new language. And a language learned later in life, scientists tell us, goes into a different part of the brain.   
  
This is obvious to the Digital Natives – school often feels pretty much as if we’ve brought in a population of heavily accented, unintelligible foreigners to lecture them. They often can’t understand what the Immigrants are saying. What does ‘dial’ a number mean, anyway?   
  
Lest this perspective appear radical, rather than just descriptive, let me highlight some of the issues. Digital Natives are used to receiving information really fast. They like to parallel process and multi-task. They prefer their graphics *before* their text rather than the opposite. They prefer random access (like hypertext). They function best when networked. They thrive on instant gratification and frequent rewards. They prefer games to ‘serious’ work. (Does any of this sound familiar?)   
  
But Digital Immigrants typically have very little appreciation for these new skills that the Natives have acquired and perfected through years of interaction and practice. These skills are almost totally foreign to the Immigrants, who themselves learned – and so choose to teach – slowly, step-by-step, one thing at a time, individually, and above all, seriously. ‘My students just don’t \_ like they used to,’ Digital Immigrant educators grouse. I can’t get them to or to . They have no appreciation for \_ or \_ . (Fill in the blanks, there are a wide variety of choices.)   
  
Digital Immigrants don’t believe their students can learn successfully while watching TV or listening to music, because they (the Immigrants) can’t. Of course not – they didn’t practice this skill constantly for all of their formative years. Digital Immigrants think learning can’t (or shouldn’t) be fun. Why should they – they didn’t spend their formative years learning with Sesame Street.   
  
Digital Immigrant teachers assume that learners are the same as they have always been, and that the same methods that worked for the teachers when they were students will work for their students now. ***But that assumption is no longer valid.*** Today‟s learners are *different*.   
  
So what should happen? Should the Digital Native students learn the old ways, or should their Digital Immigrant educators learn the new? Unfortunately, no matter how much the Immigrants may wish it, it is highly unlikely the Digital Natives will go backwards. In the first place, it may be impossible – their brains may already be different. It also flies in the face of everything we know about cultural migration. Kids born into any new culture learn the new language easily, and forcefully resist using the old. Smart adult immigrants *accept* that they don’t know about their new world and take advantage of their kids to help them learn and integrate. Not-so-smart (or not-so-flexible) immigrants spend most of their time grousing about how good things were in the ‘old country.’   
  
So unless we want to just forget about educating Digital Natives until they grow up and do it themselves, we had better confront this issue. And in so doing we need to reconsider both our methodology and our content.

* First, our methodology. Today’s teachers have to learn to communicate in the language and style of their students. This *doesn’t* mean changing the meaning of what is important, or of good thinking skills. But it *does* mean going faster, less step-by step, more in parallel, with more random access, among other things. Educators might ask ‘But how do we teach logic in this fashion?’ While it’s not immediately clear, we do need to figure it out.
* Second, our content. It seems to me that after the digital ‘singularity’ there are now *two kinds* of content: ‘Legacy’ content (to borrow the computer term for old systems) and ‘Future’ content. ‘Legacy’ content includes reading, writing, arithmetic, logical thinking, understanding the writings and ideas of the past, etc – all of our ‘traditional’ curriculum. It is of course still important, but it is from a different era. Some of it (such as logical thinking) will continue to be important, but some (perhaps like Euclidean geometry) will become less so, as did Latin and Greek. ‘Future’ content is to a large extent, not surprisingly, digital and technological. But while it includes software, hardware, robotics, nanotechnology, genomics, etc. *it also includes the ethics, politics, sociology, languages and other things that go with them.* This ‘Future’ content is extremely interesting to today’s students. But how many Digital Immigrants are prepared to teach it? Someone once suggested to me that kids should only be allowed to use computers in school that they have built themselves. It’s a brilliant idea that is very doable from the point of view of the students‟ capabilities. But who could teach it?

As educators, we need to be thinking about how to teach *both* Legacy and Future content in the language of the Digital Natives. The first involves a major translation and change of methodology; the second involves all that PLUS new content and thinking. It’s not actually clear to me which is harder – ‘learning new stuff’ or ‘learning new ways to do old stuff.’ I suspect it’s the latter.   
  
We need to invent Digital Native methodologies for *all* subjects, at *all* levels, using our students to guide us. The process has already begun – I know college professors inventing games for teaching subjects ranging from math to engineering to the Spanish Inquisition. We need to find ways of publicizing and spreading their successes.   
  
A frequent objection I hear from Digital Immigrant educators is ‘this approach is great for *facts*, but it wouldn’t work for „my subject.‟’ Nonsense. This is just rationalization and lack of imagination. In my talks I now include ‘thought experiments’ where I invite professors and teachers to suggest a subject or topic, and I attempt– on the spot – to invent a game or other Digital Native method for learning it. *Classical philosophy?* Create a game in which the philosophers debate and the learners have to pick out what each would say.   
  
It’s just dumb (and lazy) of educators – not to mention ineffective – to presume that (despite their traditions) the Digital Immigrant way is the *only* way to teach, and that the Digital Natives‟ ‘language’ is not as capable as their own of encompassing any and every idea.   
So if Digital Immigrant educators *really* want to reach Digital Natives – i.e. all their students – they will have to change. It’s high time for them to stop their moaning, and as the Nike motto of the Digital Native generation says, ‘Just do it!’ They *will* succeed in the long run – and their successes will come that much sooner if their administrators support them.

**Are today's students different?**

Are today's students different? Usually when a discussion starts about "digital natives, digital immigrants," (Prensky, 2001), "Generation Next" (Kohut, Parker, Keeter, Doherty, & Dimock, 2007) or the "digital generation" (Montgomery, 2007), I tend to change the focus of the conversation from these labels to the needs of learners and research-based, tried and tested strategies that have resulted in positive learning outcomes. I often do this because I find such labels problematic- it is important to recognize that a digital divide (Dickard & Schneider, 2009) exists and is more pervasive than many might like to even consider. And, I am not convinced learners are really any different--it is our society that is and the tools with which we have to work and communicate that are different.   
  
  
Another challenge with assigning labels to learners today, whether they were "born digital" (Palfrey & Gasser, 2008) or not, is that these terms and their meanings do not accurately represent every person that might fall into such categories. These terms are full of assumptions and biases that can seriously cloud an instructor's and employer's perception of an individual. Vaidhyanathan (2008) has written an article in the Chronicle of Higher Education that raises a similar argument, as he notes:   
  
  
Talk of a "digital generation" or people who are "born digital" … ignores the vast range of skills, knowledge, and experience of many parts of society. It ignores the needs and perspectives of those young people who are not socially or financially privileged. It presumes equal access to resources, time, knowledge, skills, and technologies. The ethnic, national, gender, and class biases of any sort of generation talk are troubling. And they are especially the case when discussing assumptions about digital media. (Vaidhyanathan, 2008, [paragraph] 9)   
  
  
Therefore, it is important for educators at all levels, and employers and instructional designers as well, to recognize that while some individuals might fit the characteristics of various labels, it is critical to recognize that … an individual is, indeed, an individual, and unfounded assumptions should not be made about him or her. In a virtual, distance learning environment, this takes on even greater importance, considering one does not have the opportunity for face-to-face interactions as one would in a normal setting.   
  
  
While I am not convinced that learners today are different, I accept that it is possible that interactions with technology, and technology's influence on brain development might actually have effects which we have not discovered or understood yet. For example, research on 24 adults … shows that regular use of the Internet by these individuals created double the amount of activity in their brains when compared to individuals who used the Internet irregularly (Interlandi, 2008). Even so, it is important to remember that research in this area is new; therefore, any generalizations about the implications and effects of digital technologies on the human brain without more research on larger populations and populations with different backgrounds, is simply premature.   
  
  
**SHIFTING THE FOCUS ON STUDENTS AND THEIR NEEDS**   
  
  
Whether one agrees with the idea that students today are different or not, it is imperative that educators, employers, and instructional designers shift their focus from "how students today might be different" to "how should I design instruction to meet the needs of my target audience" and "what do I need to change to meet the needs of my learners?" This does not mean adding gimmicks, the latest technology, or other "bells and whistles" to keep learners' attention or just to seem "current" or "innovative." Rather, it means making thoughtful, informed decisions about how to engage learners in the process of learning, accepting learners for who they are, understanding learners' strengths and weaknesses, helping them build on their strengths and diminish their weaknesses, and capitalizing on their "neomillenial learning styles" (Dede, 2005). It means putting learning and learners first, reflecting on what works and what does not, and changing instruction to meet the diverse needs of one's target audience- and not blaming individuals for being different than students one might have had 20 years ago.   
  
  
New technologies will continue to challenge our assumptions about teaching and learning, not only for distance education, but also for face-to-face and blended (hybrid) learning environments. Are today's learners different? I do not think so (until proven otherwise), but the digital tools available today for learning, teaching, and communicating are. Just think-numerous technologies available as this article goes to press did not even exist a few years ago!

**The Digital Divide**

According to some, the development of information and communications technology is increasing the gap between the rich and the poor, those with knowledge and those without, the information rich and the information poor. Instead of closing the divide, the introduction of more ICT further increases social and economic divides–not only between rich and poor countries, but also among various socioeconomic groups within countries.  
  
Others argue that ICT decreases the divide by involving countries in the global economy and providing them access to global knowledge and information for development. Nonetheless, there are stark differences in access across the world according to gender, geography (i.e., urban versus rural), income, education, age, occupation, and even ethnicity and race. The groups with the greatest access to new information and communications technology are generally well-educated, high income urban males. Poor, illiterate females in rural areas are least likely to have access to ICT.  
  
**The Digital Divide in Education**  
  
The global dimensions of the digital divide are most clearly seen in education. At the beginning of the twenty-first century many industrialized countries had begun to gear up their education systems for the knowledge economy by making major investments in computers for classrooms, in networking their schools, and in training teachers to use technology in their teaching. Thus, in the United States the ratio of students to instructional computers reached five to one and 98 percent of schools were connected to the Internet. In the United Kingdom, the ratio of students to computers was twelve to one in primary school and seven to one in secondary school while access to the Internet was virtually universal, as it was in the European Union as a whole.  
  
In contrast, most of the developing countries, with few exceptions, were more concerned with very difficult educational issues–low primary and secondary school enrollments, inadequately trained teachers, little or no access to textbooks, and ineffective school management–rather than with improving ICT. The exceptions were a small number of countries in Asia, Latin America, and other parts of the developing world that began introducing computers in classrooms, networking schools, and developing digital content to address the educational requirements of the global knowledge economy.  
  
**Education and Technology in the Balance**  
  
Does access to computers and the Internet give the education systems of industrialized countries an advantage over those in developing countries?  
While there has been good progress in providing access to ICT in schools and universities in industrialized countries, the expected benefits to education, as noted, have been difficult to measure: (1) increasing productive teaching and learning; (2) transforming teaching and learning from traditional textbook lessons to more learner-friendly, student-centered approaches that use powerful interactive tools and methods; and (3) equipping students with higher order thinking and problem-solving skills that prepare them for life in an information-based society and workplace.  
  
The experience of the industrialized countries would suggest that access to the Internet and the wealth of knowledge and information it provides does not automatically lead to measurable improvements in the quality of teaching and learning in schools. Rather, such improvements are the result of parallel efforts to enhance the teaching and learning process by training teachers, reducing class size, making textbooks available, and establishing standards of learning. Nonetheless, it is obvious that school systems everywhere, and especially in the developing countries, need to find ways of providing more students with regular and frequent access to information and communications technology and to enable students to acquire the knowledge and skills needed to support a knowledge economy.

**Bridging the digital divide**

The developing countries face massive challenges in bridging the digital divide in education. What are these challenges? And is progress possible? In order to bridge the digital divide in education, developing countries will first need to overcome the key constraints to the development of ICT in general. Too often programs fail to address the problems in an effective way. This would involve the improvement of information infrastructure, and a reduction in Internet costs in developing countries, leading to a broadening of the information society there, and for more widespread and cost-effective use of new technologies to improve education.  
  
Even with the best of intentions, however, achieving these goals will not be easy for developing countries. They lack both the money and the technical knowhow to overcome infrastructure and human resource limitations.   
  
Many feel that advances in technology will help bridge the digital divide between industrial and developing countries. Overall, the spread of Internet access is expected to be rapid in the first decade of the twenty-first century. Indeed, access to information over the Internet is already being greatly increased around the world. The development of wireless telecommunications is also expected to facilitate access to the Internet in remote rural areas where telephone service has been unavailable. And, above all, computers are likely to become both pervasive and affordable, not just on the desk top and as handheld appliances, but embedded in intelligent objects everywhere.  
  
While access to computers and telecommunications networks is necessary to bridge the digital divide, access alone is not sufficient to ensure that education systems in developing countries benefit from the Internet revolution. The governments of these countries also need to: (1) train teachers and trainers to exploit the potential of learning technologies; (2) offer free or inexpensive Internet access to schools; (3) foster capacity to develop content and instructional resources in their own language; (4) build networks and well-maintained facilities for both accessing knowledge and providing affordable lifelong learning and skill upgrading; and (5) preserve the freedom of teachers and students to explore the myriad educational resources on the web without filtering and censorship such as that which exists in China, Saudi Arabia, Iran, and other countries.  
  
Both industrialized and developing countries must also seek to address the digital divide between rich and poor. The United States has made significant progress in bridging the gap, although there are still considerable problems, especially in instructional practice–that is, in how effectively modern learning technologies are being used with different groups of students. In the developing countries, public policies to promote competition (which lowers prices and improves quality) and to make new technologies more accessible will ultimately influence availability and adoption of technology and access. However, special community-based programs by governments and nongovernmental organizations involving marginalized or rural communities, women, and minorities are also essential for bridging the digital divide.

**Closing the digital divide**

TONY COX, host: While the World Wide Web has sped up the global pace of communication, not everyone is up to speed. It's called the digital divide, and it describes the gap between those who have significant access to the Internet and those who don't.  
  
Former President Bill Clinton sought to address the digital future during his time in office with an initiative to make every public school classroom Internet-ready by the year 2000. The concern was that minority youth who were not online would be unable to compete for jobs in the new millennium.  
  
Today, black and Latino youth use media more than ever, outpacing white and Asian youth, according to a recent study by Northwestern University. But there's a big difference in how they use media, and that has created new challenges for bridging a divide that still exists.  
  
S. Craig Watkins is a professor at the University of Texas, who is with us now to explain his research on minority youth and what fuels this gap. He joins us from Austin, Texas. Welcome, Craig.  
  
S. CRAIG WATKINS: Hi, Tony. How are you?  
  
COX: I'm fine, thank you. Let's begin with this. Let's define terms. When we say digital divide, what exactly do we mean and who are we talking about?  
  
WATKINS: That's a great question. You know, I think about 15 years ago when we used the term digital divide, we were talking largely about the question or the concern around access to technology. Fast forward about 10 or 15 years later to 2011, and now when we talk about it, I think it's less about access to technology and more about participation. That is, the quality of engagement, what people are now doing with the technology that they have access to.  
  
COX: You have commented before on reports about media use among minority youth. Reports that say they use media, for example, on average 13 hours a day. Thirteen. First of all, that's a startling amount of time. Does that capture all media? Being online, being on cell phones, or what?  
  
WATKINS: You know, I think the study that you're alluding to, which was published I think about a year or so ago, but it deals primarily with just a combination of different types of media platforms: TV, music media, print, video games, online media. And increasingly, you know, we know that mobile is becoming more and more part of young people's media time as well.  
Although I'm not sure if the 13 hours that are quoted in this study actually account for the amount of time that young people are spending watching video and listening to music on their mobile phones.  
  
COX: For example, blacks on Twitter, it said in some of these reports, that they are the biggest users by far, disproportionately to their numbers in the population. How do you explain that?  
  
WATKINS: Yeah. And that's what I mean by sort of a shift. I mean, 15 years ago, I mean, this - the idea, right, that African-Americans would be kind of on the front, on the cutting edge, a platform or a technology like Twitter would've been inconceivable, right?  
We would be having a very different conversation 15 years ago. And now when we look at the landscape, right, Latinos and African-Americans are just as likely to be on Facebook, just as likely to be using mobile devices, just as likely to be using Twitter. And so now I think the question isn't so much about access, right, getting to the technology, but now about participation.  
  
COX: If you're just joining us, I'm Tony Cox and you're listening to TELL ME MORE from NPR News. We're talking about the digital divide among young people - the gap between whites and people of color and access to the Internet. We're joined today by S. Craig Watkins, a sociology professor who specializes in digital youth culture.  
Craig, I want to go back to a point that you just made, and talking about it's not so much a matter of access, perhaps, but a matter of participation. Are minority youth - and I don't even know if this is a fair way to say it - are they ahead or behind in terms of their participation?  
  
WATKINS: Yeah. It's a fascinating question because if you define progress largely as using technology, increasingly black and Latino youth have caught up and in some situations even surpassed their white and more affluent counterparts. We know, for example, that they're spending more time online or as much time online.  
Again, we know that they're using their mobile devices, for example, for a wider range of things, so a much more robust activity around mobile devices: listening to music, playing games, social networking - those types of things. But, you know, there's a whole other sphere of technology, behavior and technology used, particularly in relation to young people.  
There is a community of young people who use technology not only, right, to sort of consume content, but also to create content, to produce content, to become kind of manufacturers and producers of their own kind of information landscape.  
And those require very different kinds of skills. What we call very different kinds of new media literacies. And what we don't quite know is to what degree are those literacies distributed evenly across race and ethnicity and across class.  
  
COX: Give me an example of what you're talking about - the kinds of creations that you're referring to.  
  
WATKINS: We're working with a group of students this summer, for example, it's a four-week program and they're essentially designing video games. And the video game is for a client. It's kind of getting the students, you know, thinking about and learning not only about game design technology, but also about, you know, the environment and green technology and building sort of, you know, green-based architecture.  
And this is a group of students who traditionally, you know, aren't necessarily exposed to these kinds of opportunities, exposed to these types of assignments. The kids who are really on the cutting edge of technology, again, are using technology to create and design, you know, content.  
  
COX: Who are we talking about? Which kids are doing that?  
  
WATKINS: That tends to track primarily along the lines of class, and which in this country in some ways begins to intersect with race. So let me just give you an example of a study that my colleague Mimi Ito and some of her colleagues produced about three or four years ago in a book called "Hanging Out, Messing Around and Geeking Out."  
And they discovered, sort of, two types of technology users - young technology users. There was the one group that they characterize as primarily using media to interact with their friends. But then there was a whole different sort of community of kids who were primarily drawn to the Internet for what they called interest-based reasons.  
Like, they had a passionate hobby. Maybe it was a game. Maybe it was fan fiction. Maybe it was fashion. And they were seeking out other people who had those kinds of interests and developing a kind of depth expertise and a kind of learning community, a kind of learning ecology. Those kids tended to be kids who came from affluent communities, you know, rich social networks from, you know, very affluent school districts, which tends to be white and Asian.  
And the question that we now want to pursue and some follow-up work that we're doing is: Are all kids accessing those kinds of opportunities? Are all kids accessing those kinds of online communities, online spaces that really enrich and empower their participation in the digital world?  
  
COX: What can be done to get more people involved in myriad ways of using the Internet and digital media?  
  
WATKINS: It seems to me that the richest and most promising attempts to do this are really kind of happening in the informal learning spaces. So they're happening in after-school programs, they're happening in the summer camps, summer workshops, which is interesting and raises a whole other set of questions about why schools aren't able to provide these kinds of opportunities.  
But I think it's happening right through community, technology leaders. I think it's happening through social entrepreneurs who have decided, right, that these issues are so important that the digital divide today is really about digital literacy, right, and how do we begin to create environments, create spaces that encourage and support kids' ability to develop the kinds of digital media skills that they will need in the 21st century in what I call kind of islands of kind of innovation, right?  
It's happening, you know, maybe in a couple places, you know, here or there. I'm seeing it in Washington, D.C. I'm seeing it in Oakland, here in Austin, in Chicago. I mean it's happening in a variety of places, but it doesn't seem to be, right, a kind of cohesive or kind of coherent effort. But one that's kind of scattered across different communities driven primarily by visionaries, driven primarily by social entrepreneurs who have decided that it is a space that they want to step into, a space that, again, schools have been inadequate in servicing.  
  
COX: S. Craig Watkins is a professor at the University of Texas who studies the social and digital media behavior of young people. He joined us from Austin, Texas. Craig, thank you.  
  
WATKINS: Sure. Thank you.  
  
  
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**Ethical issues**  
Ethical issues often relate to whether schools are providing students with equal access to technology. Gender-equity issues arise when girls are treated differently than boys in terms of the use of, and encouragement to use, technology. Girls tend to enroll in fewer computer classes, spend fewer hours on the computer either at home or at school, and are less likely to choose majors in computer-related fields than do boys. For example, in 2000 only 15 percent of the students who took the Advanced Placement Computer Science exam were girls. There are a number of factors that contribute to this gender difference, including the limited number of female role models in computer-related fields, adults who especially encourage boys to use the computer and computer games, and software that tends to targets boys' interests more than that of girls.  
  
The digital divide is the division that exists between the information rich and the information poor. Advanced technologies, and the Internet in particular, provide easy access to vast amounts of information. Digital inequities can exist along racial, economic, academic achievement (low-achieving versus high-achieving classes), and geographic (rural, urban, and suburban) lines. A student in a rural school that lacks fast Internet connections does not have the same access to information as a student near a major city.  
  
The digital divide also extends beyond the school. More economically advantaged children usually have access to information sources through Internet connections and microcomputers at home. Those who are more disadvantaged must rely upon limited school and public library resources. Minority students may be discouraged from accessing online content because of an absence of exposure to computers in general or because of a lack of racially and ethnically diverse information on the Internet. Finally, computers are often used as a reward for high achieving students, leaving out those students with poorer academic records, while some students are simply not encouraged to use technology to fuel their interest in academics.

**Seconds out, round two**

The explosion of new web services - such as 'blogs' and 'wikis' - has led many to believe that the internet is now entering a second phase. It's finally beginning to resemble a truly interactive learning tool, says Stephen O'Hear.  
  
Events in Silicon Valley have, traditionally, had a trickle-down effect on teaching and learning. But with the arrival of the internet and teachers who write blogs regularly, this is changing. One idea being put forward in the "blogosphere" is that we are experiencing the second phase of the development of the web or "web 2.0", with the explosion of new web services, applications, and business models that are helping to reshape the net.  
  
If the early version of the web took a "top-down" approach to content, which consisted mainly of standalone and static web pages that were hard to update, web 2.0 takes a more "bottom-up" approach - where web services and applications allow users to publish content without the need to write code and exploit the network's potential to support greater social interaction and collaboration. As a result, we are seeing a renaissance of Tim Berners-Lee's original vision of a read/write web through the creation of what Tim O'Reilly (a US internet pioneer who was among the first to popularise the web 2.0 idea), calls an "architecture of participation".  
  
Like the web itself, the early promise of e-learning - that of empowerment - has not been fully realised. The experience of e-learning for many has been no more than a hand-out published online, together with a simple multiple-choice quiz. Hardly inspiring, let alone empowering. But by using these new web services, e-learning has the potential to become far more personal, social and flexible.  
  
Rather than being based on cumbersome (and often expensive) virtual learning environments, e-learning 2.0 should adopt what David Weinberger, author and fellow at Harvard's Berkman Institute for Internet and Society, calls a "small pieces, loosely joined" approach, combining the use of discrete but complimentary tools and web services, based on "open standards", which can be made to work together. Many teachers are doing this through use of web logs or "blogs" (a form of online micropublishing, typically of personal thoughts and weblinks), wikis - web publishing software that lets users create and edit web pages using a standard web browser - and other forms of social software, as well as various digital media and devices - like podcasting.  
  
**Personal publishing**  
  
Blogs remove the technical barriers to writing and publishing online, and the journal format encourages bloggers to keep a record of their own thinking over time. Blogs also facilitate critical feedback by letting readers add comments. These could be from teachers, students, or the wider community.  
  
For students, a blog can be used as a living record of their learning: a place to pose questions, publish work in progress or provide links to (and comments on) relevant web resources.  
  
Teachers who are subject specialists may want to start their own subject-based blog where they can provide up-to-date information and commentary on their subject area, as well as posting questions and assignments, and linking to relevant news stories and websites. Media studies teacher Pete Fraser runs one such blog (using Google's free blogging service blogger.com) for his students at Long Road sixth-form college, in Cambridge. Visit <http://longroadmedia.blogspot.com/>  
  
**Collaborative publishing**  
  
A key theme of many web 2.0 applications is that they harness the collective intelligence of users, and this is particularly true of wikis. As with blogs, wiki software makes it possible to publish a website with very little technical knowledge but puts a greater emphasis on collaborative rather than personal publishing. Every wiki entry has an "edit this page" button so that users can not only add new content but make changes to existing pages.  
  
Perhaps the best-known use of a wiki is the web-based encyclopedia, Wikipedia ([www.wikipedia.org](http://www.wikipedia.org/)), which is authored and maintained by a thriving online community. Critics argue that because there is no central editor, the validity and accuracy of its entries varies greatly. In its defence the wiki community points out that if a user spots a mistake, they are free to correct it for themselves, and that any vandalism is usually eradicated within five minutes. As an introduction to wikis, why not have students (perhaps as part of a history lesson) research and write a missing entry then see how the wikipedia community evaluates that entry and what changes they make?  
  
**Folksonomy**  
  
Folksonomy is another example of the way in which the web 2.0 attempts to harness the collective intelligence of its users. The word "folksonomy" refers to the collaborative way in which information is being categorised on the web. Instead of using a centralised form of classification, users are encouraged to assign freely chosen keywords to pieces of information or data, a process known as tagging. Web 2.0 services that use tagging include those designed to allow users to publish and share various media, such as photos ([www.flickr.com](http://www.flickr.com/)) or videos ([www.youtube.com](http://www.youtube.com/)), as well as most blog software, where each entry can be assigned keywords.  
  
Delicious (<http://del.icio.us/>) is a "social bookmarks manager" that allows users to create their own personal collection of weblinks and which (because they are stored online) can be accessed from any computer connected to the net. Each bookmark is given a short description and tagged with keywords, and collections can be shared. All teachers and students would benefit from using a social bookmarking service.  
  
**Media and devices**  
  
The use of digital media in schools has been around for years but the sharing of finished work has tended to be isolated within the school. A central theme of web 2.0 is to make publishing and sharing content as simple as possible. Together with the recent explosion of mobile media devices such as video-capable mobile phones and MP3 players (see [www.ipodined.org](http://www.ipodined.org/)), this means that teachers and students now have many more opportunities to publish and share digital media.  
  
**Content aggregation**  
  
Perhaps the most important element of web 2.0 is that it offers the kind of connectivity to bring all these disparate elements together. For example, using an online RSS reader, such as bloglines.com, it's possible to track and be alerted to new and relevant content across a range of web services and applications. Updated content could include a student's new blog entry or comment, changes to a project wiki, newly published media, or useful weblinks recently discovered by a teacher.  
  
It is this level of integration and participation that is driving the web 2.0 revolution - a phenomenon offering a very different approach to e-learning.  
  
**·** Stephen O'Hear is a fellow for the National Endowment for Science, Technology and the Arts ([www.ohear.net](http://www.ohear.net/))

**Why you need to use storytelling for learning**

I’m sure you’ve heard by now that storytelling can make learning more effective. Stories help us process and remember information. Perhaps they even touch a part of our consciousness associated with the magic and creativity of childhood.

In my desire to become a better storyteller, I attended a session on the subject while at the [Presentation Summit,](http://www.betterppt.com/summit/) a conference where the topics overlap surprisingly well with the interests of training professionals and learning specialists.

Here are the key points I gathered from a session titled, The Art of Storytelling, presented by [Jon Thomas.](http://www.presentationadvisors.com/) I modified them for learning experience designers as needed.

## 1. Stories are the emotional glue that connects the audience to the message

Much of what people remember from a learning experience are the feelings of the underlying message rather than a multitude of small facts (which are better reserved for job aids). Stories are an important way to tap into the heart of the audience, providing a channel for conveying a deeper message based on emotion.

## 2. Information presentation should be constructed around a story

Any kind of presentation—whether it be online training or a live presentation—will benefit from a story construction. Organizing information into a format with a beginning (setting the stage), middle (the challenge) and ending (new reality) can work for many topics.

## 3. People want to know about origins

When we watch or read about a superhero, we always remember the person’s origins. We know where they came from and the circumstances that created their super powers. People are defined by their origins and people are curious about where people (or fictional characters) come from, how they change and how they evolve. Include this type of information in your next story.

## 4. Stories reshape knowledge into something meaningful

For centuries, people have used stories to pass on knowledge. When information is embedded in the context of a story, it is transferred to a listener or reader in a unique way. According to the presenter of this session, new research shows that 70% of what we learn is consumed through storytelling.

## 5. Stories make people care

When you know your audience—their pains, frustrations and joys—your stories can reflect their emotions and experiences. As learners begin to see themselves in the story and begin to identify with it, they start to care. [Nancy Duarte](http://theelearningcoach.com/elearning_design/visual-storytelling-nancy-duarte/), author of Resonate, states that a story serves as a moment of emotional appeal.

## 6. Stories transcend one’s current environment

Good storytelling can transport learners out of their stuffy meeting rooms and offices into an adventurous world away from the workplace. In this altered reality, the mind becomes more open to perceiving and thinking in new ways. This is an ideal position from which to learn.

## 7. Stories are motivating

Stories can motivate an audience toward a learning goal. They are ideal for [attitudinal training](http://theelearningcoach.com/elearning_design/attitudinal-training/) because when an audience is motivated, they no longer need to be persuaded. An encouraging story will inspire someone to take action.

## 8. People take time for stories

Have you ever noticed that even the busiest of people will stop to listen to someone’s story or to tell one of their own? Stories are why people are drawn to novels and movies and gossip magazines. If you want to maintain an audience’s attention, you’re more likely to do it through storytelling.

## 9. Stories are more likely to be shared

Because we are so attuned to stories, people love to share them. They are like hooks that draw people in as they are passed from one person to the next. If you have any doubts, check out the thousands of [Facebook Stories](http://stories.facebook.com/). This is where people share how they use Facebook and the meaning it has in their life. Do you need to spread the word about something? Put it in a story and see if it gets shared.

## 10. Stories give meaning to data

Many people perceive data as meaningless numbers. This happens when the data is disconnected to anything important in their experience. But when the data is placed in the context of a story, it comes alive. One of the most well-known examples of this is Hans Roling’s presentation below. If you haven’t seen it yet, take the four minutes to watch.

**10 ways to learn in 2010**

There are so many cool ways to learn online now. The whole world is a school. This list is meant for continuous learners and for procrastinators looking for distractions in the coming year.

## 1. Learn through Visual Search Engines

How would you like your search engine to show results in a collage? [Spezify](http://spezify.com) does just that. It’s a visual search engine that draws content from all over the Web, particularly social media sites. Your collage might show a book from Amazon, a YouTube video and a page from a blog or web site. You drag the results to navigate the page and then click the graphic to view the media. Although the results might not be as robust as with conventional search engines, it’s a lot more fun. Other visual search tools include: [viewzi](http://www.viewzi.com/), [Kart00](http://www.kartoo.com/) and [search-cube](http://www.search-cube.com/).

## 2. Learn from Word Clouds

How can you search for something on a site when you’re not sure what’s there? Though Word Clouds aren’t new, have you used them as a learning tool? If you go to [Wordle](http://wordle.net) and enter a site’s url or feed url, you can use the word cloud as an index to the site. Look for words of interest and then search for those articles or pages.

You can also use word clouds as the basis for writing a poem, for studying another language and for comparing two pages of information. Janet Clarey [compared two articles](http://www.brandon-hall.com/workplacelearningtoday/?p=8567) from this site using word clouds. You can also create tag clouds with [TagCrowd](http://tagcrowd.com/) and you probably figured there had to be a [tweetcloud](http://tweetcloud.com).

## 3. Ask a Question

Although Question and Answer sites aren’t new on the Web, we’re now at a point where there are enough experts online and enough Q&A sites to make finding an answer more feasible. Some sites crowd-source the answers while others use mentors to answer questions in their area of expertise. These sites are also great for browsing through when you’re in procrastination mode.

Here are a few: [Amazon’s Askville](http://askville.amazon.com/Index.do), [Yahoo Answers](http://answers.yahoo.com/), [Answerbag](http://www.answerbag.com/), [Gotta Mentor](http://gottamentor.com/index.aspx), [BlurtIt](http://www.blurtit.com/), and [WikiAnswers](http://wiki.answers.com/). For answers to eLearning related questions, try one of the [LinkedIn](http://linkedin.com) eLearning Groups with a high membership, like The eLearning Guild or Instructional Design & E-Learning Professionals’ Group. FYI: You can always shoot me a question through the contact page and I’ll answer or crowd-source it.

## 4. Think Visually

One of the best ways to learn is to look at things from a new perspective. [Prezi](http://prezi.com) can help you do this. It is one of the most innovative tools for creating nonlinear presentations. Check out their Showcase.

Expressing and organizing your ideas in mind maps is another approach to expanding or changing your perspective. Try these free online mind mapping tools, some of which are collaborative: [Mindmeister](http://www.mindmeister.com/) (check out their Public Mind Maps), [Xmind](http://www.xmind.net/) and [Mindomo](http://www.mindomo.com/).

## 5. Hang Out with Professors

We now have lots of options for taking free online college courses. Imagine a great lecture with no tests, papers or deadlines. That’s right. Check out [UC Berkeley Webcasts](http://webcast.berkeley.edu/), which has a mix of video and audio lectures and [MIT’s Open Courseware](http://ocw.mit.edu/OcwWeb/web/home/home/index.htm), which consists of PDF lecture notes and some multimedia presentations. [OpenLearn](http://www.open.ac.uk/openlearn/home.php) has a [Learning Space](http://openlearn.open.ac.uk/index.php?__utma=1.2060087280.1262561406.1262561406.1262561406.1&__utmb=1.56.10.1262561406&__utmc=1&__utmx=-&__utmz=1.1262561406.1.1.utmcsr=education-portal.com%7Cutmccn=%28referral%29%7Cutmcmd=referral%7Cutmcct=/articles/Universities_with_the_Best_Free_Online_Courses.html&__utmv=-&__utmk=186517673) with lecture notes and discussion forums. You can also reuse and remix their content to create your own courses in their [Lab Space](http://labspace.open.ac.uk/?__utma=1.2060087280.1262561406.1262561406.1262561406.1&__utmb=1.56.10.1262561406&__utmc=1&__utmx=-&__utmz=1.1262561406.1.1.utmcsr=education-portal.com%7Cutmccn=%28referral%29%7Cutmcmd=referral%7Cutmcct=/articles/Universities_with_the_Best_Free_Online_Courses.html&__utmv=-&__utmk=186517673). Other open university courses are at [Carnegie Mellon](http://oli.web.cmu.edu/openlearning/) and [Tufts University](http://ocw.tufts.edu/). Don’t forget the lectures from University of Oxford and Stanford on iTunesU.

## 6. Watch Documentaries

If you like to learn from documentaries, you can catch some free ones at [Get Docued](http://getdocued.net/docubase/doku-tag-887), [Free Online Documentaries](http://freeonlinedocumentary.com/) and [Free Documentaries](http://freedocumentaries.net/).

## 7. Tune In to Big Ideas

Discuss, watch and get inspired at some of the sites that promote new and innovative ideas. You’ve probably seen the videos at [Ted](http://ted.com), but what about [Big Think](http://bigthink.com/), [Fora.tv](http://fora.tv/) and [Ideas Project](http://ideasproject.com/index.webui)?

## 8. Learn through Twitter

Do you ever search through tweets to discover the latest resources and conversations? Real time search is very now. For example, I just searched for ‘elearning’ (I know I’m boring) and got directed to a great discussion about how to help learners get the most from eLearning. You can search directly on Twitter, but they say the results are less than stellar. Other real time search engines that get better reviews are [Twazzup](http://www.twazzup.com/), [Tweetzi,](http://tweetzi.com/) [IceRocket](http://www.icerocket.com/?tab=twitter) (searches other social media too) and [TweetScan](http://www.tweetscan.com/index.php).

## 9. Hop Into a Debate

Learn about all sides of an issue through online debating. [Debategraph](http://debategraph.org/Default.aspx) uses a visualization tool to show the complexity and multiple aspects of world issues. You can start at the Gallery to pick an issue. Then select Stream View (the small print below) to see the visualization. You can then explore the issue and add your own viewpoint. Also, check out [Debate.org](http://www.debate.org/), where you read the debates and vote on a winner.

## 10. Create a Mashup

Mashups let you combine and remix information, media, content, web applications and services. Making a mashup helps you perceive information in new ways and is a learning experience in itself. Two mashup platforms are Pipes and Scrapplet. [Pipes](http://pipes.yahoo.com/pipes/) is an aggregator tool for manipulating and remixing content and data from around the web. [Scrapplet](http://scrapplet.com/index.htm) uses a drag and drop approach for mashing up content, particularly from social media sites.

How do you plan to learn online this year?

**Technology in Education- current trends**  
  
Susan M. Williams  
  
Computers and Internet connections are becoming widely available in schools and classrooms. In 1999, 99 percent of teachers in the United States had access to a computer in their schools, and 84 percent had one or more computers in their classrooms. At the same time, Internet connections were also widespread, with 95 percent of schools and 63 percent of classrooms having access. Worldwide, many countries are making the creation and diffusion of information and communications technology (ICT) an important priority. Even in developing countries, usage is increasing dramatically. As ICT becomes more widely available, teachers and policymakers are turning their attention to the difficult task of understanding how best to integrate this technology into learning environments.  
  
ICT can be used in many different ways, and how it is integrated into educational settings depends largely on teachers' instructional goals and strategies. Changes in the goals of education during the latter part of the twentieth century, coupled with increases in the amount and type of available technology, has created changes in teachers' use of technology. In the 1970s and early 1980s the primary goal of instruction was to have students memorize important information and procedures. Instruction was teacher-led and dominated by lectures, followed by practice using worksheets and short-answer tests. Students worked alone to complete assignments, and when help was needed they consulted parents, teachers, or textbooks for assistance. If computers were available in classrooms during this time period, their use mirrored this dominant mode of instruction; that is, they were primarily used to present passages of text and test students' comprehension and memory for information contained in the passages.  
  
Research on learning has demonstrated the shortcomings of this type of instruction. Students often forget memorized information, or they fail to apply it in situations where it would be useful. They need help in connecting new information to what they already know and in extending and applying their knowledge to new problems. Researchers in the early twenty-first century believe that students learn best when they work to combine their own past experience with new information in order to solve problems that are personally meaningful to them.  
  
In addition to changes in the understanding of how students learn, there have been substantial changes in what educators and policymakers believe students should know how to do. The exponential growth in information since 1950 has shifted the purpose of education. Information has become abundant and easily accessible. Rather than reading the unified perspective typically presented by a textbook, students have access to many different points of view. Instead of memorizing, students now need assistance in learning how to find and select relevant information for problems they need to solve. They need to learn how to collaborate with others as they solve these problems and communicate their solutions to their teachers and to the world beyond their classroom.  
  
Along with changes in what students should know and an increased understanding of how they learn, new approaches to instruction are being advocated. Instead of listening to lectures and memorizing facts and procedures, educational reforms suggest that students learn best in the context of solving complex, realistic problems. Traditional computer-assisted instruction (CAI) and many integrated learning systems (ILSs) deliver precisely this form of instruction in a range of subject-matter areas. Typically computers dedicated to ILSs are clustered in computer laboratory settings, rather than being located in individual teacher's classrooms. Students who acquire new information as they solve problems are able to understand its usefulness, remember it, and use it to solve problems in the future. Solving interesting problems is more likely to stimulate a student's interest than memorizing isolated facts, and this interest has been shown to positively affect learning. Students solving real problems view their efforts as real work and have a sense of purpose and value.  
  
Organizing instruction around problem solving makes new demands on teachers, including locating meaningful problems and projects and providing students with the resources and guidance for solving them. Teachers are finding that ICT can help them meet these demands, and they are integrating it into their instruction in many new and exciting ways.  
  
**Technology and New Forms of Instruction**  
  
**Using technology to find and represent educational problems**. One major challenge for teachers interested in problem-based learning is locating problems that are appropriate for their students and for the topics that they need to learn. Problems must be complex enough to support sustained exploration and encourage collaboration, and they should have multiple interrelated parts to develop students' ability to break problems down and organize their solutions. Representing and communicating such complex problem situations is an important function of technology. Unlike problems that occur in the real world, technology can incorporate graphics, video, animation, and other tools to create problems that can be explored repeatedly. Multimedia representations are easier to understand than problems presented as text. One example of using technology to present problems is the mathematical problem-solving series, The Adventures of Jasper Woodbury. Each problem in the Jasper series is presented as a video story that ends when the main character experiences a problem that can be solved using math. Using technology that can be easily searched and paused for inspection, students search the video looking for clues to help them understand and solve the problem. In one episode, students explore a variety of transportation methods and routes to rescue a wounded bald eagle. They compare their solution plans and develop ways to determine which plan is best.  
  
Microworlds are another type of technology used to present problems. One example is Thinkertools, a computer-based learning environment that simulates aspects of Newtonian physics. Using the Thinkertools microworld, students can manipulate various aspects of the environment, observe the results, and attempt to discover the rules that govern this simulation.  
  
Internet and videoconferencing technology allow students to participate in projects sponsored by researchers around the world. In the Jason Project, satellite and Internet technology bring classroom students into direct real-time contact with leading scientists, conducting scientific research expeditions around the globe. Each year the project explores a different location in order to help students understand the earth's biological and geological development. Some of the past expeditions have studied deep-sea archaeology, compared shallow and deep ocean habitats, studied plate tectonics and volcanoes, and compared conditions experienced in space and under the oceans. In addition to observing research activities, students are able to ask questions and get immediate answers from the scientists.  
  
Whatever type of technology is used, an important goal is to create problem representations that are interactive and under the learner's control. The student creates a plan for investigating the problem, and the technology creates an environment that makes flexible exploration possible.  
  
**Using technology to find educational resources.** A second function of technology in problem-based learning environments is locating information needed to solve problems or do other kinds of research. In the past, teachers attempting a problem-based curriculum felt the need to limit problems to those for which they had expertise or the local library had resources. Now the World Wide Web brings a seemingly endless amount of information on almost any subject, and it is possible for students to choose topics based on personal interest rather than availability of resources.  
Internet research projects are gaining rapidly in popularity. In the spring of 1998, 30 percent of teachers surveyed (and 70% of those with high-speed Internet connections) reported they had assigned Internet research tasks for their students during the school year. Use of the Internet to gather information for solving problems sometimes resembles a modern version of library research, in which students gather and synthesize information from published reports. Despite the fact that the task seems traditional, the characteristics of this new medium require special skills for students. The sheer volume of information allows students to study almost any topic, but also makes it more difficult to locate precisely the right information from among the thousands, or even millions, of sites that might be located. In addition, the ease of publishing and accessing materials on the Internet increases the likelihood that students will encounter inaccurate or biased information. As a result, students must learn new strategies for conducting searches and evaluating the information that they retrieve.  
  
In addition to its function as a source of information, the Internet's capability for communication and interaction provides many innovative educational opportunities. Many times students are unable to find or understand the available resources. In such cases, teachers are also turning to ICT to link their students with mentors and subject-matter experts. In one such project, fourth-and fifth-grade students in McAllen, Texas, compared the experiences of their families on the Texas La Frontera to colonial life in the original thirteen U.S. colonies, with the help of the director of a historic preservation center and museum in Fredericksburg, Virginia.  
  
Students carrying out scientific investigations can use the Internet to make observations and collect data. For example, fourth and fifth graders in California collected insects and sent them to San Diego State University. Using two-way audio and video connecting the school and the university, scientists guided the students in using an electron microscope to examine their specimens. Technology has made it possible to collect data from places students could never visit. In recent projects, high school students explored the floor of the Monterey bay by studying video from remotely operated robots, and middle school students were given time to use the Hubble telescope.  
  
Students also use technology to collect data in their schools and communities. For example, using handheld computers outfitted with various types of probes, students can monitor the water quality at various locations in nearby streams or lakes. By transmitting their individual readings to a laptop computer in a field laboratory they can quickly graph their data and visually compare readings.  
  
**Using technology to summarize and present findings.** In the past, students memorized and used formulas and models created by others to solve problems. Students often used these formulas, especially in the early stages of learning, with little understanding. In the early twenty-first century computer tools provide the opportunity for students to construct and test their own models using tools such as spreadsheets or concept maps. This type of instruction deepens students' understanding of abstract concepts and allows these concepts to be taught at an earlier age.  
  
Once students have summarized their data and other information, they typically communicate their findings to others. In the past, this meant writing a report to be read by the teacher. Writing reports is still the most widespread use of ICT, with 61 percent of U.S. teachers assigning students word processing tasks. In addition to text, students also use computer-created graphics, video, and animations to communicate their ideas.  
The teacher is not the only audience for students' presentations. Students are frequently expected to present their work and receive feedback from their peers and the world outside their classroom. Whether they are using presentation software to accompany a face-to-face presentation or developing materials to put on the Web, the trend is for students to be able to communicate and defend their work to a broad audience. This increases students' perception that problem-based learning is real work for real audiences.  
  
**Using technology for collaboration and distance education.** There are many opportunities for individual students to use technology to enhance their learning. These include online courses that provide students in remote locations with opportunities for customized curriculum and advanced placement courses. These courses are conducted entirely online and offer asynchronous interaction among faculty and students. Because they allow students to participate anytime and from anywhere, online courses are becoming increasingly popular among postsecondary students whose job and personal commitments do not allow them to meet a regular class schedule.  
  
Opportunities for interaction with peers from other countries can also contribute to knowledge and understanding of other cultures. ICT makes this type of communication possible for anyone with Internet access. For example, the KIDLINK project encourages students up to age fifteen to use the Internet to build a global network of friends. KIDLINK participants discuss issues ranging from how to make and keep friends to war and peace.  
  
**Teachers' Integration of Technology in Instruction**  
  
Research has shown that learning to incorporate technology into instruction occurs over time and follows a pattern. Initially, teachers incorporate new technologies into the things that they traditionally do. Then, after observing changes in their students–including improvements in behavior, absenteeism, collaboration, and independent learning–teachers gradually begin to experiment and use technology to teach in new ways. It often takes four years or more from initial attempts until changes in student learning can be observed.  
  
Research indicates that change at all levels will be necessary to bring about widespread and effective use of technology. Successful programs must devote a substantial portion of their budget to extensive professional development and technical support; they must encourage a culture of collaboration in which teachers work together to explore more effective uses of technology; and they must modify their assessment systems to measure changes, such as deeper understanding and improved problem solving, that result from effective technology use.  
  
**Future Trends**  
  
Advances in hardware and software have the potential to bring about fundamental changes in how technology is integrated and even in education itself. Computers formerly tethered to desktops by cables are being rapidly replaced by wireless laptop and palmtop models that free students to move about the school; collect, share, and graph data on field trips; and communicate their whereabouts and progress to teachers and parents.  
Monitoring students' independent learning in these flexible environments will be supported by sophisticated new assessment technologies that will help teachers collect and analyze student data and make instructional decisions. These tools will continually assess students' work and provide feedback to them and their teachers. Such assessment has the potential to make time-consuming standardized testing unnecessary and to personalize the curriculum for every student. Ubiquitous, well-integrated technology tools will bring educators closer to redefining the educational enterprise and providing customized, just-in-time solutions for the learning needs of adults and children.